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अनुभाग 2 क्रियात्मक परिवर्धक

Indian Standard

SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 5 ANALOGUE INTEGRATED CIRCUITS — ESSENTIAL RATINGS AND CHARACTERISTICS

Section 2 Operational Amplifiers

UDC 621·3·049·77·037·33·621·375·4

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Semiconductor Devices and Integrated Circuits Sectional Committee, LTD 010

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FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalised by the Semiconductor Devices and Integrated Circuits Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This standard is one of a series of standards on integrated circuits. Other sections of this part are:

Section 1 General

Section 3 Audio amplifier, video amplifier and multichannel amplifers for telecommunication

Section 4 R. F. and I. F. amplifiers

Section 5 Voltage and current regulators

Section 6 Analogue switching circuits

This standard is based on IEC Pub 748-3 'Semiconductor devices, integrated circuits : Part 3 Analogue integrated circuits', issued by the International Electrotechnical Commission (IEC).

It is proposed to withdraw the existing Indian Standard, namely, IS 7440 (Part 3/Sec 1) : 1976, dealing with essential ratings and characteristics of analogue integrated circuits covering operational amplifiers, as soon as the clauses therein are covered in the new series [IS 12970 (Part 5/Sections 1 to 6)].

In reporting the result of a test or analysis made in accordance with this standard, if final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

SEMICONDUCTOR DEVICES — INTEGRATED CIRCUITS

PART 5 ANALOGUE INTEGRATED CIRCUITS — ESSENTIAL RATINGS AND CHARACTERISTICS

Section 2 Operational Amplifiers

1 SCOPE

This standard (Part 5/Sec 2) cover the essential ratings and characteristics of operational amplifiers of analogue circuits.

2 REFERENCES

The following Indian Standards are necessary adjuncts to this standard:

IS No.	*Title*
1885 (Part 7/Sec 5) : 1971	Electrotechnical vocabulary: Part 7 Semiconductor devices, Section 5 Integrated circuits and micro electronics
3715 (Part 1) : 1971	Letter symbols for semiconductor devices: Part 1 General aspects (*first revision*)
5000 Series	Dimensions of semiconductor devices
12970 (Part 1) : 1990	Semiconductor devices — Integrated circuits : Part 1 General

3 TERMINOLOGY

For the purpose of this standard terms and definitions given in IS 1885 (Part 7/Sec 5) and provisions of 3 of IS 12970 (Part 1) : 1992 shall be applicable.

4 LETTER SYMBOLS

For the purpose of this standard the letter symbols given in IS 3715 (Part 1) : 1971 shall be applicable.

5 FUNCTION

5.1 Amplifier intended to effect mathematical operations when used in a closed loop.

5.2 The characteristics of an operational amplifier approximate to those of an ideal amplifier.

5.2.1 The ideal voltage amplifier (having two inputs and one output) is characterised by:

a) an infinite voltage gain,

b) an infinite input impedance,

c) a zero output impedance, and

d) a bandwidth starting from zero frequency.

5.2.2 The ideal current amplifier (having two inputs and one output) is characterised by:

a) an infinite current gain,

b) a zero input impedance,

c) an infinite output impedance, and

d) a bandwidth starting from zero frequency.

NOTE — The characteristics of an operational amplifier are such that it can be used for many applications other than those given above.

6 DESCRIPTION OF CIRCUIT

6.1 Technology

The technology used in the manufacture should be stated, for example semiconductor monolithic integrated circuit, thin film integrated circuit, hybrid integrated circuit, microassembly, etc.

6.2 Details of Outline and Encapsulation

6.2.1 Where applicable reference to standard outlines and bases (*see* IS 5000 series) *or* outlines and base drawing showing dimension and tolerances should be given.

6.2.2 *Method of Encapsulation*

6.2.3 Marking : The drawing of the case with the marking should be reproduced.

6.3 Block-Diagram and Terminal Connections

The block-diagram and the identification of the connections should be shown on the same drawing. If the encapsulation has metallic parts, any connection to them from external terminals should be indicated. The connections with any associated external electrical elements should be stated (*see also* 9).

As additional information, the complete electrical diagram can be reproduced, including significant parasitic elements, but not necessarily with indications of the values of the circuit components.

7 RATINGS (LIMITING VALUES)

7.0 The ratings given must cover the operation of the integrated circuit over the specified range of operating temperatures. Where such ratings are temperature-dependent, this dependence should be indicated.

7.1 Electrical Limiting Values

7.1.1 *Power Supply Voltage(s)*

a) Maximum value(s) and polarity(ies),

b) Maximum permissible ripple on the supply voltage(s),

c) Maximum values of transients or spurious signals from the supplies for a specified time duration, and

d) Maximum value of the voltage between a common supply terminal and case or reference terminal where appropriate.

NOTE — The sequence of the application of supply voltages should be given, where appropriate.

7.1.2 *Power Supply Current(s)*

a) Maximum values, where appropriate; and

b) Maximum values, for a specified duration (external fault conditions), where appropriate.

7.1.3 *Input Terminal Voltages*

Maximum values, with respect to a common reference terminal, including bias voltages.

7.1.4 *Output Terminal Voltages*

Maximum values, with respect to a common reference terminal, including bias voltages.

7.1.5 *Input Terminal Currents*

Maximum values, including bias currents.

7.1.6 *Output Terminal Currents*

Maximum values, including bias currents.

7.1.7 *Impedances (Where Appropriate)*

Maximum values for the impedances of the supplies to which the circuit is connected.

7.1.8 *Short-Circuit Conditions (Where Appropriate)*

Maximum duration of a short-circuit between terminals or between terminals and ground.

7.2 Temperatures

7.2.1 *Operating Temperature*

Minimum and maximum values of ambient or reference point operating temperature.

7.2.2 *Storage Temperatures*

Minimum and maximum values.

7.3 Power Dessipation (Where Appropriate)

Maximum value over the operating temperature range.

8 RECOMMENDED OPERATING CONDITIONS (WITHIN THE SPECIFIED OPERATING TEMPERATURE RANGE)

8.0 For **8.1** to **8.4**, the variation with temperature should be stated, where appropriate.

8.1 Power Supplies

8.1.1 Polarities, values and tolerances for voltages or currents and, where appropriate, impedances.

8.1.2 Normal value(s) of the supply current(s).

8.1.3 Maximum value(s) of the impedance(s) of the supplies, where appropriate.

8.2 Input Terminals

8.2.1 Value(s) of the voltage(s) and/or current(s) of the input signal or of the signal generator.

8.2.2 Value(s) of the bias on the input terminals where appropriate.

8.3 Output Terminals

8.3.1 Nominal value(s) of the voltage(s) and/or current(s) of the output signal and of the load impedance.

8.3.2 Value(s) of the bias on the output terminals, where appropriate.

8.4 External Elements

Values and tolerances for the external elements that must be associated with the circuit.

9 ELECTRICAL CHARACTERISTICS

9.0 Electrical characteristics should be stated as follows:

a) If external elements are essential for the operation of the circuit, the electrical characteristics should include the effect of such external elements.

b) If external elements are optional only, the electrical characteristics should be given for the integrated circuit alone. The effect of adding specified external elements on the characteristics should then be indicated in application data.

9.1 Characteristics at 25°C (Ambient or Reference-point Temperature)

9.1.1 *Power (or Supply Current) Consumption* (P_{tot})

Typical value under specified conditions.

9.1.2 *Input Characteristics*

9.1.2.1 *Input impedance or admittance*

Minimum and maximum values for specified values of:

a) load impedance,
b) measuring frequency, and
c) input signal amplitude.

9.1.2.2 *Magnitude of input offset voltage and/or current* (V_{IO})

Maximum values for specified values of source resistances, if they affect the values of these characteristics.

9.1.2.3 *Input bias current* (I_{IB})

Maximum value for zero or specified voltage in common mode.

9.1.2.4 (*Equivalent input drift*)

Maximum value under specified conditions.

9.1.2.5 *Common-mode rejection ratio* (K_{CMR})

Minimum or maximum value for specified values of:

a) amplitude of input signal in common mode,
b) output voltage with zero input signal in common mode,
c) supply voltage(s),
d) frequency,
e) adjustment of the gain control (if it exists), and
f) load and source impedances.

9.1.2.6 *Common-mode input voltage range*

Minimum and maximum values for specified values of:

a) supply voltage(s),
b) load and source impedance(s),
c) common-mode rejection ratio, and
d) additional components to be connected externally.

9.1.3 *Output Characteristics*

9.1.3.1 *Output impedance or admittance*

Minimum and/or maximum values for specified values of:

a) supply voltage(s),
b) source impedance,
c) frequency,
d) output signal amplitude.

9.1.3.2 *Maximum rate of change of the output voltage (for large-signal operation)* (S_{VOM})

Typical and where appropriate minimum value(s) under specified conditions.

NOTE — The rise and/or fall time of the input pulse should be negligible compared to the rise/fall time of the operational amplifier.

9.1.3.3 *Output voltage swing* (V_{OPP})

Typical and minimum values for specified supply voltage and load resistance and, where appropriate, for a specified value of total distortion.

9.1.3.4 *Short circuit output current*

Minimum and where appropriate, maximum values for specified values of:

a) supply voltage(s),
b) differential and common-mode input voltages, and
c) duration of the short-circuit, where appropriate.

9.1.4 *Forward Transfer Characteristics*

9.1.4.1 *Open-loop gain*

Minimum and maximum values for specified values of:

a) supply voltage(s),
b) frequency,
c) adjustment of the gain control (if it exists),
d) load and source impedance(s), and
e) amplitude of the output signal at which the gain is measured.

9.1.4.2 *Operation with sinusoidal and/or pulse signals*

Maximum and/or minimum values for one or more of the following characteristics:

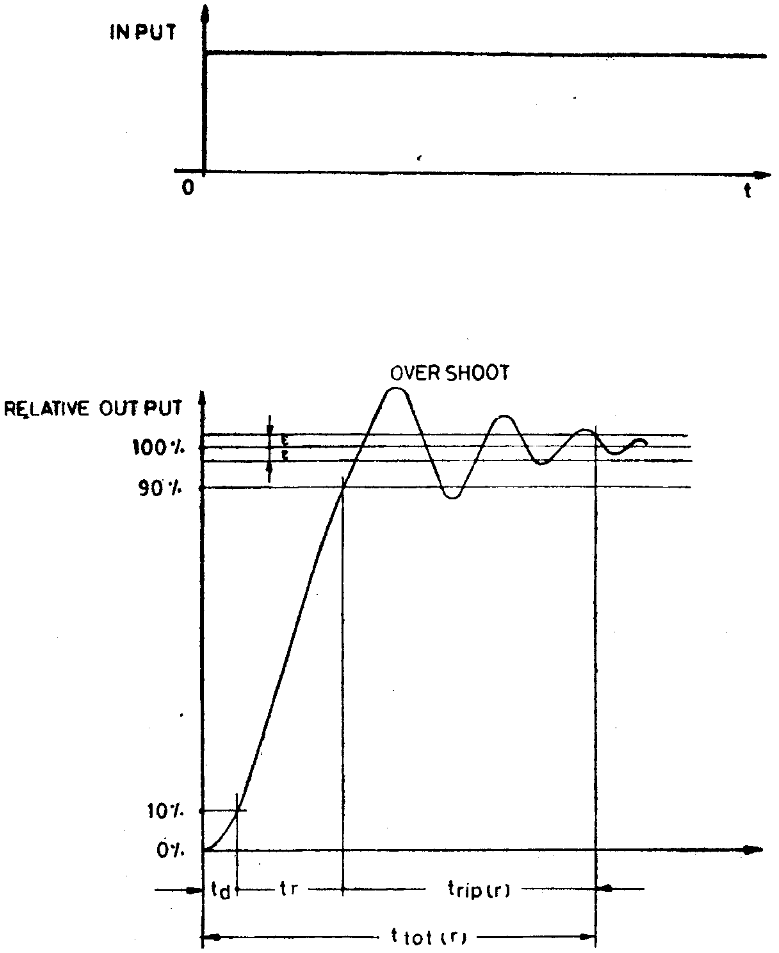
a) frequency for which the open-loop gain has decreased by 3 dB from its low frequency value,
b) frequency for unity gain, and
c) pulse response time.

9.1.4.3 *Response times*

The following times shall be specified:

a) delay time : t_d
b) rise/fall time : t_r (or t_f)
c) ripple time : t_{rip}
d) total response time : t_{tot}

Only three of these four parameters shall be stated (*see* Fig. 1).



ε = specified percentage of the final (quiescent) value

FIG. 1 EXAMPLE OF RESPONSE TIMES OF LINEAR AMPLIFIERS

These parameters should be stated as follows:

Typical and, where appropriate, maximum value under the following specified conditions:

a) unity-gain configuration,

b) input and feedback resistance values with which unity-gain configuration is realized,

c) phase compensating conditions (configuration and values of the compensating network, if any),

d) load conditions (configuration and values of the loading network), and

e) level of input signal.

NOTE — The rise time of the input pulse should be negligible compared to the slope time of the operational amplifier.

9.1.4.4 *Overshoot* (K_{OV}) — *See* Fig. 1.

Maximum value under the same specified conditions as the response times.

9.1.4.5 *Upper limiting frequency for full output voltage swing (where appropriate)*

Typical and minimum values, for specified values of:

a) supply voltage(s),

b) unity-gain inverter configuration,

c) input and feedback resistances with which unity-gain configuration is obtained,

d) phase compensating conditions (configuration and values of the components of the compensating network, if any),

e) load conditions (configuration and values of the components of the loading network),

f) distortion factor of the output signal, and

g) output voltage.

9.1.5 *Reverse Transfer Characteristics*

Not appropriate.

9.1.6 *Interaction Between the Amplifier and the Supply Lines*

The following information should be given under appropriate specified conditions:

a) Maximum signal from the amplifier to the supply lines,
b) The transfer characteristic from the supplies to the input of the amplifier, and
c) The impedance of the amplifier at the supply terminals.

This should be specified both for steady state and transient conditions.

9.1.7 *Noise (Where Appropriate)*

Maximum value.

The noise should be specified in terms of noise factor or in terms of equivalent input voltage and/or current, for specified values of supply voltage(s), source impedance/admittance, frequency and bandwidth.

9.1.8 *Cross-talk Attenuation (for Multiple Amplifiers)*

Minimum value for specified values of:

a) supply voltage(s),
b) amplitude or output signal,
c) signal frequency,
d) load and source impedances,
e) additional components to be connected externally, and
f) conditions for other amplifiers.

9.2 Effects of Variations of Temperature or Supply Voltages on the Essential Characteristics (*see* **9.1**)

The changes in the following characteristics with temperature and supply voltages should be stated:

a) This information should be given either for the typical value of the characteristic or for the limit (maximum or minimum) value of the characteristic.

b) This information should normally be given as application data for the device, and not as acceptance criteria for acceptance against a specification. The data called for in **9.2.1** should be given at a specified value of supply voltage(s) and the data required in **9.2.2** should be given at a temperature of 25°C.

9.2.1 *Variation with Temperature*

a) Power (or supply current) consumption (*see* **9.1.1**),
b) Magnitude of input offset voltage and/or current (*see* **9.1.2.2**),
c) Input bias current (*see* **9.1.2.3**),
d) Common-mode rejection ratio (*see* **9.1.2.5**), and
e) Open-loop gain (*see* **9.1.4.1**).

9.2.2 *Variation with Supply Voltage(s)*

a) Power (or supply current) consumption (*see* **9.1.1**),
b) Output voltage swing (*see* **9.1.3.3**), and
c) Open-loop gain (*see* **9.1.4.1**).

NOTE — Additional information regarding the variation of certain parameters with supply voltage(s) may also be given.

10 MECHANICAL CHARACTERISTICS AND OTHER DATA

10.1 Provision of **5.5** of IS 12970 (Part 1) shall apply.

11 APPLICATION DATA

11.1 Information concerning the variations of the characteristics given in **8.1** with supply voltage, temperature, source and load impedances, may be given.

11.2 Any other pertinent information concerning particular applications may be given, for example, curves of the typical variation of input or output impedances or admittances versus frequency, the other specified conditions remaining unchanged.

11.3 Any external elements to be associated with the integrated circuit should be referred to its terminals. These external elements should appear in two distinct tables:

a) the first table should include the associated elements which are specified to a function, or which determine an operation, and

b) the second table should include the associated elements which serve as correcting elements.

Each table should include three columns:

a) in the first column, the integrated circuit terminals concerned should be identified,

b) in the second column, the nature of the external elements concerned should be indicated (for example; RC network), and

c) in the third column, the resulting characteristics of the integrated circuit plus the external elements should be indicated.

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